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Washington, D.C. 20231

jc135 U.S. PTO
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05/18/99

Sir: Transmitted herewith for filing is the patent application of:

Stanley Dale Vierk; Hong Ying Wang

For: HIGH MODULUS AND HIGH DAMPING PLASTIC COMPOSITE DISC SUBSTRATE FOR IMPROVED SERVO CONTROL BY INJECTION AND CO-INJECTION MOLDING

Also enclosed are:

- ☒ 2 sheets of drawings, Formal ; Informal ☒
— Assignment of the Invention to: Seagate Technology, Inc.
— Recordation Form.
☒ Declaration for Patent Application (Unsigned).
— Power of Attorney by Assignee.

FOR:	SMALL ENTITY	OTHER
Basic fee:	\$ 380.00	\$760.00
Total Claims: (20) <u> 20 </u> Extra: x 9 = \$	x 18 = \$.00
Indep Claims: (03) <u> 3 </u> Extra: x39 = \$	x 78 = \$.00
Multiple Dependent Claim(s): no +130 = \$	+ 260 = \$	
Total	\$.	Total \$760.00

- ☒ Our Check in the amount of \$760.00 to cover the filing fees is enclosed.
☒ The Commissioner is authorized to charge any fees required or credit any over-payment to Acct. 06-1300 (Order #A-66435/JAS/MSS). A copy of this sheet is enclosed.

Respectfully submitted,

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**HIGH MODULUS AND HIGH DAMPING PLASTIC COMPOSITE
DISC SUBSTRATE FOR IMPROVED SERVO CONTROL
BY INJECTION AND CO-INJECTION MOLDING**

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RELATED APPLICATIONS

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This application claims priority from provisional patent application Serial No. 60/086,360 filed May 19, 1998, and the entire disclosure of the provisional patent application is hereby incorporated herein by reference.

FIELD OF THE INVENTION

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The field of this invention is data storage systems. More particularly, the invention pertains to plastic and plastic composite substrates used as discs in magneto-optical (MO) and magnetic recording (MR) data storage systems.

BACKGROUND OF THE INVENTION

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With the advance of magneto-optical and magnetic recording technologies, the design of the discs, and particularly the substrates, in such data storage systems have been the subject of great interest. One area of interest is the development of discs that can store increased densities of data. This can be achieved by formatting the disc with a particular pattern which provides for servo control. Formatting is done by forming a pattern of pits or grooves in the surface of the disk or substrate.

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To provide formatting requires the use of a plastic substrate. Conventional hard discs, such as those used with MR systems, are made of aluminum or glass. Conventional CD's do use polycarbonate plastic substrates; however, such applications are limited to low density storage, and to low rotation speeds of only a few thousand rpm. Further, such polycarbonate substrates are not suitable for use with a "flying" recording head as used with MR and MO data storage systems, because of its low modulus and low damping properties giving poor shock and vibration performance.

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The inventors have found that when substrates made from polycarbonate, or other

materials such as amorphous polyolefin that have similar physical and mechanical properties to polycarbonate, are used in a MR or MO disk drive applications the substrate is prone to failure causing the disk drive to fail. The MR and MO disk drive applications typically employ rotation speeds of greater than 5000 rpm and utilize flying recording heads, and when using conventional polycarbonate and similar substrates, the head to disk tracking becomes very difficult for the servo system to accommodate due to axial and radial disk vibrations.

Thus, the currently available plastic substrates are unsatisfactory for MR and MO applications. Accordingly, it is desirable to provide a data storage system which addresses the aforementioned limitations, and in particular to provide a disk or substrate which is capable of formatting for high density data storage and is operable at high rotational speeds with flying heads.

SUMMARY OF THE INVENTION

Accordingly, it is an object of the present invention to provide an improved storage system or recording device.

More particularly, it is an object of the present invention to provide a plastic or plastic composite substrate that is used as a disk in MO or MR data storage systems.

These and other objects and advantages are achieved by the present invention disclosed herein where a data storage system substrate is provided, comprising at least one plastic material. The plastic material has mechanical strength and rigidity, and in particular it exhibits a modulus of about 350kpsi or greater. In another aspect of the invention, the plastic material includes a damping agent for damping shock and/or vibration forces that the disk may be subject to during its operation. In another aspect of the invention a data storage system is provided having means for reading and writing information to a storage disk, and means for storing said information in said storage disk, wherein said storage disk is comprised of at least one plastic or plastic composite material, and the plastic or plastic composite material exhibits a modulus of about 350kpsi or greater.

In another aspect of the invention, an apparatus is provided comprising a disk drive

spindle motor; and at least one data storage disk mounted on the disk drive spindle having means for exhibiting a modulus of about 350 kpsi or greater. Further the apparatus includes means for strengthening and/or damping energy that the apparatus is subjected to.

BRIEF DESCRIPTION OF THE DRAWINGS

Additional objects and features of the invention will become more clearly apparent from the following detailed description and appended claims when taken in conjunction with the drawings, in which:

Figure 1 is a cross-sectional view of a data storage system substrate, in accordance with one embodiment of the present invention.

Figure 2 is a cross-sectional view of a data storage system substrate, in accordance with an alternative embodiment of the present invention.

Figure 3 is a cross-sectional view of a data storage system disk, in accordance with an alternative embodiment of the present invention.

Figure 4 is a cross-sectional view of an apparatus of the present invention.

DETAILED DESCRIPTION OF THE INVENTION

The inventors have discovered an improved data storage system substrate design that provides for the use of a plastic or plastic composite substrate that is suitable for formatting of servo control patterns, but that exhibits improved shock and vibration performance, making the inventive substrates suitable for magnetic recording (MR) and magneto-optical (MO) data storage applications which operate at high rotational speeds and employ flying heads.

Of particular advantage, the present invention provides a plastic, or plastic composite, substrate that is comprised at least in part of a high modulus material 11 as shown in Fig. a. Plastic materials or plastic composites finding use in the present invention are materials having a modulus of greater than 350 kpsi, more preferably having a modulus in the range of about 400 to 3,000kpsi, with a modulus higher than 1,000kpsi being most preferred.

Optionally, the substrate composition may be formed by combining polymer resins or resin blends with certain fillers and other additives to form a high modulus plastic composite. The fillers may be classified into two groups, i.e. reinforcing agents and damping agents. The reinforcing agents increase the modulus of rigidity of the substrate. Examples of reinforcing agents include anisotropic fillers such as glass fibers, carbon fibers and the like, and isotropic fillers such as mineral particles and the like. The damping agent increases the damping ability of the substrate. Examples of damping agents include elastomeric particles and the like. Examples of high modulus plastic materials includes, but are not limited to: amorphous polysulfone (PSU), amorphous polyethersulfone (PES), amorphous polyetherimide (PEI), semi-crystalline polyphenylsulfide (PPS), semi-crystalline polyphthalamide (PPA), liquid crystal polymer (LCP), polyetheretherketone (PEEK), and other plastic materials that have a rigid backbone with bulky groups like an aromatic ring in the backbone. Additionally, polycarbonate (PC) may be used as a skin material in combination with a core material (described further below). Further filled polycarbonate may be used as a core material. Chemical properties, and certain molding conditions, of certain of the materials are shown in Table 1 below and are compared against conventional polycarbonate (PC):

Table 1

Name	PC	PSU	PES	PEI	PPS	PPA (filled)	LCP (filled)
modulus (kpsi)	300	380	420	480	550	1,100	2,280
Density (g/cm ³)	1.20	1.24	1.37	1.27	1.40	1.54	1.70
Specific Heat (J/kgK)	1,750	1,675	1,150	2,036	2,080	1,262	-
Tg (°C)	150	190	220	217	85	127	-
Tm (°C)	-	-	-	-	280	310	340
Melt T (set) (°C)	345	350	385	385	345	340	340
Mold T (°C)	100	140	150	140	140	150	135

heat removed on cooling (J/g)	429	352	270	499	426	240	-
thermal conductivity (W/mk)	0.20	0.16	0.16	0.22	0.29	0.40	-
cooling time used (sec)	<7	25	25	15	30	35	15
water absorption (%)	0.15	0.20	0.54	0.25	0.03	0.14	<0.1

The above listed plastic and plastic composites are typically classified as engineering plastics and are commercially available from a variety of suppliers, such as Amoco, Philip 66, General Electric and the like.

In another aspect of the invention, a plastic or plastic composite substrate is provided that includes a damping agent. The damping agent may be any material that absorbs energy as opposed to transmitting energy. For example, in one embodiment of the present invention, a filler material is used as a damping agent. The filler material may be added to the plastic or plastic composite. Thus, the plastic or plastic composite substrate of the present invention may be filled or unfilled. Filler materials include, but are not limited to: glass fibers, carbon fibers, mineral particles, and other damping particles.

When providing a plastic or plastic composite substrate according to the present invention, it is preferred that the concentration of the fillers in the substrate be in the range of about 5 to 65 weight percent. The particular concentration of filling agent selected is determined by the type of agent used and the plastic or plastic composite material used. Preferably, the concentration is towards to high end of the range, which will provide the greatest mechanical and damping capability; however, if the concentration is too high, the surface flatness and/or smoothness of the substrate will deteriorate. Further, manufacturing of the substrate may become less feasible. Thus, the size and type of the filler agent is influenced by the fabrication technique used and/or the application. For example, when the substrate is comprised of a single layer, it is preferred that the filler particles be as small as practical. Alternatively, when the substrate includes a core layer, the size of the particles in the core layer are not important so long as they provide the desired mechanical and damping performance, and is processible.

Accordingly, any of the above mentioned high modulus plastic and plastic composite materials may be filled with the aforementioned damping agents to provide a plastic substrate which exhibits desirable mechanical properties of strength and damping of vibration and shock forces. Such characteristics make the plastic substrate of the present invention suitable for MR and MO data storage systems, and of particular advantage for such systems that operate at rotational speeds of greater than 5000 rpm and which utilize flying heads.

In another embodiment of the invention, a multi-layer plastic or plastic composite substrate is provided. In particular, the substrate is comprised of two or more layers of plastic or plastic composite materials as shown in Figs. 2 and 3. Specifically, as shown in one illustrative example of Fig. 2, the substrate 5 is comprised of multiple plastic material layers, in this case three layers. A middle, or core layer 12 is sandwiched between two outer, or skin layers 14. The core layer 12 may be filled with an agent 13, such as a reinforcing agent of mineral particles, glass or carbon fibers; or a damping agent such as elastomeric particles and the like to provide desirable mechanical and/or damping properties. Alternatively, the core layer 12 may be unfilled. Preferably, the skin layers 14 is unfilled in order to provide a smooth surface finish to the substrate 14. While three layers are shown in Fig. 2, it should be understood that any number of layers may be used, such as more than three, or even only two layers in which case one of the skin layers 14 would be omitted and the core layer 12 would no longer be sandwiched between two skin layers. Additionally, the core layer 12 may be made up of multiple sub layers, for example where each sub layer is made up of layers of different plastic materials and/or with differing damping agents.

The substrate shown in Fig. 2 is particularly advantageous for providing a substrate with desirable mechanical and damping characteristic due to the core filled layer 12, while maintaining a smooth and flat surface due to the unfilled skin layers 14. Further, any one of, or any combination of the core and skin layers may be comprised of a high modulus material, thereby adding strength to the substrate. In yet another embodiment of the present invention, the core layer 12 is comprised of a filled high modulus plastic material, thereby providing the desirable strength and damping capability to the substrate, and then one or more of the skin

layers may be comprised of a conventional polycarbonate material.

The thickness of the layers 12 and 14 are not critical, and may be varied depending on the geometry of the disk drives. In general, the thicker the substrate the more rigidity, better performance and ease of processing, and this is preferred if the drive design will accommodate the thicker substrate. The inventors have found however, that to provide the greatest strength and damping qualities, it is preferred for the core layer 12 to have a greater thickness than the skin layer 14. However, this is not a requirement and the core layer 12 can be of the same thickness as, or a lesser thickness of, the skin layer 14. In the preferred embodiment, the substrate 5 has three layers, one core layer and two skin layers, and the core layer is comprised of polyetherimide filled with mineral particles, and the skin layers are comprised of pure polyetherimide.

In another aspect of the present invention, a disk 10 is provided as illustrated in Fig. 3. The disk 10 includes the plastic substrate 15 of the present invention as described above, and multiple layers formed atop the plastic substrate 15. Fig. 3 shows these multiple layers formed atop only one side of the substrate (i.e. a one sided disk); however, these multiple layers may also be formed atop the other side of the substrate (i.e. a doubled sided disk). In the exemplary embodiment, the substrate 15 is comprised of a core layer 12 filled with a damping agent 13 sandwiched between two skin layers 14. The multiple layers are formed atop skin layer 14 and include an aluminum layer 16. Formed atop the aluminum layer 16 is a magnetic layer 18, and then a protective layer 20. To provide good tribological properties, a carbon overcoat layer 22 is formed atop the protective layer 20 and a lubrication layer 24 is applied atop the overcoat layer 22. Of particular advantage, the plastic substrate may be formatted with a pattern for enhanced servo control, and yet the substrate exhibits desirable mechanical properties such that the disk 10 is suitable for use in MR and MO data storage systems, and in particular those systems which operate at rotation speeds of greater than 5000 rpm and employ flying heads. Thus, in another aspect of the present invention a data storage system is provide having the disk of the present invention and further including a read/write head, an actuator for moving the read/write head and a motor from rotating the disk (not

shown).

In another aspect of the invention, an apparatus 30 is provided including a disk drive spindle motor 32 and at least one data storage disk 34 mounted on the disk drive spindle 32 as shown in Figure 4. The apparatus further includes a housing 35, a read/write head 36 and an actuator assembly 37 and actuator arm 38 for positioning the read/write head 36. The data storage disk 34 has means for exhibiting a modulus of about 350 kpsi or greater. Further the apparatus includes means for strengthening and/or damping energy that the apparatus is subjected to.

The plastic substrate and disk of the present invention may be made by conventional methods. The substrates may be made by plastic injection molding techniques, and by co-injection molding techniques. Co-injection molding methods are particularly suitable for making the multilayered substrate embodiment of the present invention having the core material with one or more skins formed atop the core material.

Experimental

Plastic and plastic composite substrates and disks according to the present invention were prepared and tested. The following examples are offered by way of illustration and not by way of limitation.

Ten injection molded plastic substrates were prepared with a diameter of 130mm and a thickness of 1.2mm. The substrates were comprised of polyetherimide with a formatted surface. Disks were formed with the ten plastic substrates by sputtering atop the substrates a MO layer structure, having a carbon overcoat and a lubrication layer. The substrates were subjected to glide tests at 5 micron inches (125mm) and showed a good average defect rate of only 0.80.

Additional experiments were conducted to prepare substrates formed of pure PEI in accordance with the present invention. Disks were prepared having a diameter of 130 mm and a thickness of 1.2 mm. The disks were single side formatted. The substrates were formed by injection molding using a Technoplas SIM-4749A machine with cavity pressure control. The

clamping force applied was 47 ton. The metal temperature was 380 C and a mold temperature of 185 C was used. The maximum injection pressure of the molding machine was about 30,000 psi with an injection rate of about 68 cm³/sec. The substrates formed were very flat and exhibited a disk roughness of a few angstroms depending on the roughness of the stamper. The pit replication (formatting) was very good. These substrates were then prepared as disks having a quadric-layer and tri-layer MO structures, both with carbon overcoats and a lubricant. Glide tests were performed at 5 micron inches and the disks showed good average defect rates.

As has been described, an improved plastic substrate and disk has been provided. Of particular advantage the vibration characteristics of plastic disc substrates used in the manufacture of magnet optic and hard discs are significantly improved resulting in better head to disc servo control, by providing a high modulus plastic material, or by combining polymer resins or resin blends with certain isotropic fillers and other additives to form a high modulus plastic composite. The resultant plastic composite substrate have higher frequency and lower amplitude vibration properties when excited during impact or rotation in a disc drive application. The plastic composite substrate exhibit imported mechanical/physical properties which improve the vibration characteristics for better head/disc servo control. Further, in one variation of the invention, plastic substrates for use in magnet optic or hard discs are made by co-injection molding two or more plastic materials into a substrate mold cavity such that a substrate core is formed from a plastic with excellent damping properties and with a low roughness outer substrate surface formed from a plastic that replicates the servo pit pattern. When excited by impact or disc rotation the higher damping core material will dampen the vibration of the substrate in a disc drive application. Having a plastic substrate core with excellent vibration damping changes the vibration characteristics and makes the servo system more effective in head to disc tracking at higher rotations and higher densities.

Thus, an improve data storage system substrate and disk having a high modulus plastic material, and optionally additionally a damping agent, has been described. While the present invention has been described with reference to a few specific embodiments, the description is illustrative of the invention and is not to be construed as limiting the invention.

Various modifications and changes may occur to those skilled in the art without departing from the true spirit and scope of the invention as defined by the appended claims.

100 101 102 103 104 105 106 107 108 109 110 111 112 113 114 115 116 117 118 119 120 121 122 123 124 125 126 127 128 129 130 131 132 133 134 135 136 137 138 139 140 141 142 143 144 145 146 147 148 149 150 151 152 153 154 155 156 157 158 159 160 161 162 163 164 165 166 167 168 169 170 171 172 173 174 175 176 177 178 179 180 181 182 183 184 185 186 187 188 189 190 191 192 193 194 195 196 197 198 199 200 201 202 203 204 205 206 207 208 209 210 211 212 213 214 215 216 217 218 219 220 221 222 223 224 225 226 227 228 229 230 231 232 233 234 235 236 237 238 239 240 241 242 243 244 245 246 247 248 249 250 251 252 253 254 255 256 257 258 259 260 261 262 263 264 265 266 267 268 269 270 271 272 273 274 275 276 277 278 279 280 281 282 283 284 285 286 287 288 289 290 291 292 293 294 295 296 297 298 299 300 301 302 303 304 305 306 307 308 309 310 311 312 313 314 315 316 317 318 319 320 321 322 323 324 325 326 327 328 329 330 331 332 333 334 335 336 337 338 339 340 341 342 343 344 345 346 347 348 349 350 351 352 353 354 355 356 357 358 359 360 361 362 363 364 365 366 367 368 369 370 371 372 373 374 375 376 377 378 379 380 381 382 383 384 385 386 387 388 389 390 391 392 393 394 395 396 397 398 399 400 401 402 403 404 405 406 407 408 409 410 411 412 413 414 415 416 417 418 419 420 421 422 423 424 425 426 427 428 429 430 431 432 433 434 435 436 437 438 439 440 441 442 443 444 445 446 447 448 449 450 451 452 453 454 455 456 457 458 459 460 461 462 463 464 465 466 467 468 469 470 471 472 473 474 475 476 477 478 479 480 481 482 483 484 485 486 487 488 489 490 491 492 493 494 495 496 497 498 499 500 501 502 503 504 505 506 507 508 509 510 511 512 513 514 515 516 517 518 519 520 521 522 523 524 525 526 527 528 529 530 531 532 533 534 535 536 537 538 539 540 541 542 543 544 545 546 547 548 549 550 551 552 553 554 555 556 557 558 559 560 561 562 563 564 565 566 567 568 569 570 571 572 573 574 575 576 577 578 579 580 581 582 583 584 585 586 587 588 589 590 591 592 593 594 595 596 597 598 599 600 601 602 603 604 605 606 607 608 609 610 611 612 613 614 615 616 617 618 619 620 621 622 623 624 625 626 627 628 629 630 631 632 633 634 635 636 637 638 639 640 641 642 643 644 645 646 647 648 649 650 651 652 653 654 655 656 657 658 659 660 661 662 663 664 665 666 667 668 669 670 671 672 673 674 675 676 677 678 679 680 681 682 683 684 685 686 687 688 689 690 691 692 693 694 695 696 697 698 699 700 701 702 703 704 705 706 707 708 709 710 711 712 713 714 715 716 717 718 719 720 721 722 723 724 725 726 727 728 729 730 731 732 733 734 735 736 737 738 739 740 741 742 743 744 745 746 747 748 749 750 751 752 753 754 755 756 757 758 759 760 761 762 763 764 765 766 767 768 769 770 771 772 773 774 775 776 777 778 779 780 781 782 783 784 785 786 787 788 789 790 791 792 793 794 795 796 797 798 799 800 801 802 803 804 805 806 807 808 809 810 811 812 813 814 815 816 817 818 819 820 821 822 823 824 825 826 827 828 829 830 831 832 833 834 835 836 837 838 839 840 841 842 843 844 845 846 847 848 849 850 851 852 853 854 855 856 857 858 859 860 861 862 863 864 865 866 867 868 869 870 871 872 873 874 875 876 877 878 879 880 881 882 883 884 885 886 887 888 889 890 891 892 893 894 895 896 897 898 899 900 901 902 903 904 905 906 907 908 909 910 911 912 913 914 915 916 917 918 919 920 921 922 923 924 925 926 927 928 929 930 931 932 933 934 935 936 937 938 939 940 941 942 943 944 945 946 947 948 949 950 951 952 953 954 955 956 957 958 959 960 961 962 963 964 965 966 967 968 969 970 971 972 973 974 975 976 977 978 979 980 981 982 983 984 985 986 987 988 989 990 991 992 993 994 995 996 997 998 999 1000

What is Claimed:

1. A substrate for use in is a data storage system, comprising:
at least one plastic or plastic composite material;
said plastic or plastic composite material exhibiting a modulus of about 350 kpsi or greater.
2. The substrate of claim 1 wherein said plastic or plastic composite material exhibits a modulus in the range of about 400 to 3,000 kpsi.
3. The substrate of claim 1 wherein said plastic or plastic composite material is selected from: polysulfone (PSU), polyethersulfone (PES), polyetherimide (PEI), polyphenylsulfide (PPS), polyphthalamide (PPA), liquid crystal polymer (LCP), polyetheretherketone (PEEK), polycarbonate (PCB) and any combinations thereof.
4. The substrate of claim 1 wherein said plastic or plastic composite material further includes a filler such as a damping agent or a reinforcing agent.
5. The substrate of claim 4 wherein said reinforcing agent is selected from carbon fibers, glass fibers, mineral particles, and any combinations thereof;
6. The substrate of claim 4 wherein said damping agent is selected from elastomeric materials.
7. The substrate of claim 4 wherein the filler has a concentration in the range of about 5 to 65 weight %.
8. The substrate of claim 1 where said one or more plastic or plastic composite materials

comprises two or more layers of said materials and any combination thereof.

9. The substrate of claim 1 further comprising:
said plastic composite material forming a core layer; and
said plastic material forming one or more skin layers formed atop said core layer.
10. The substrate of claim 9 wherein said core layer includes a damping agent and/or a reinforcing agent dispersed in said core layer.
11. The substrate of claim 1 wherein said substrate is formatted with servo control patterns.
12. A disk including the substrate of claim 1 and further comprising:
a MO or MR layer structure; and
a carbon overcoat formed atop said MO or MR layer structure.
13. The disk of claim 12 further comprising:
a read/write head;
an actuator for moving said read/write head; and
a motor for rotating said disk.
14. A substrate for use in is a data storage system, comprising:
at least one core layer made of a plastic or plastic composite material; and
at least one skin layer made of a plastic or plastic composite material , and formed
atop at least one surface of said core layer, wherein at least one of said core or skin layers
exhibit a modulus of about 350 kpsi or greater.
15. The substrate of claim 14 wherein said plastic or plastic composite material is

selected from: polysulfone (PSU), polyethersulfone (PES), polyetherimide (PEI), polyphenylsulfide (PPS), polyphthalamide (PPA), liquid crystal polymer (LCP), polyetheretherketone (PEEK), polycarbonate and any combinations thereof.

16. The substrate of claim 14 wherein said plastic or plastic composite material further includes a filler such as a damping agent or a reinforcing agent and wherein the filler has a concentration in the range of about 5 to 65 weight %.

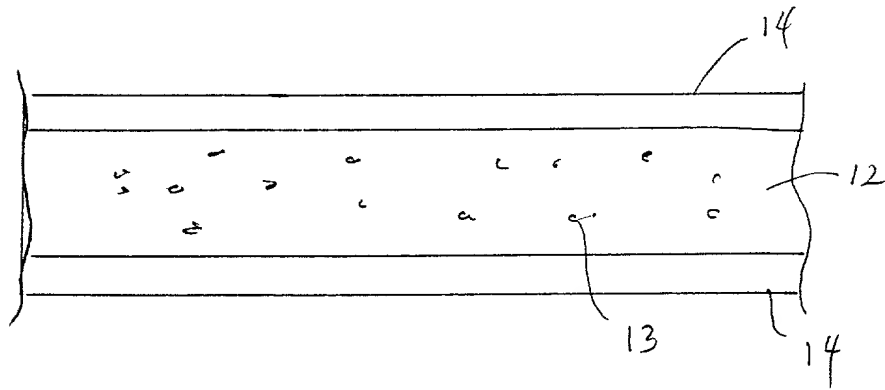
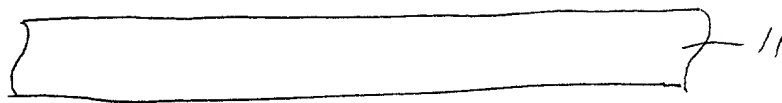
17. The substrate of claim 16 wherein said reinforcing agent is selected from carbon fibers, glass fibers, mineral particles, and any combinations thereof;

18. The substrate of claim 16 wherein said damping agent is selected from elastomeric materials.

19. An apparatus, comprising:
a disk drive spindle motor; and
at least one data storage disk mounted on said disk drive spindle having means for exhibiting a modulus of about 350 kpsi or greater.

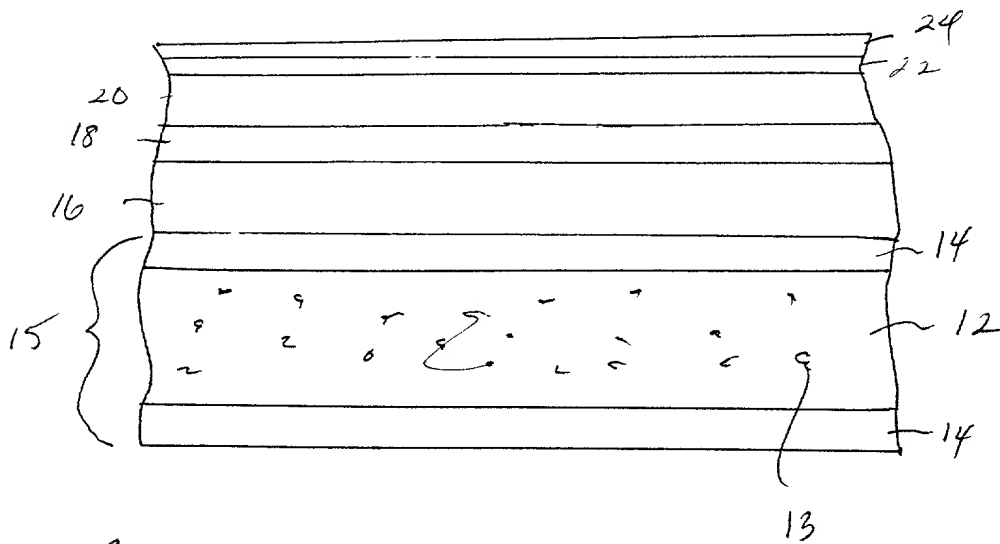
20. The apparatus of claim 19 further including means for strengthening and/or damping energy that the apparatus is subjected to.

FIG - 1



5 ↗

FIG - 2



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FIG - 3

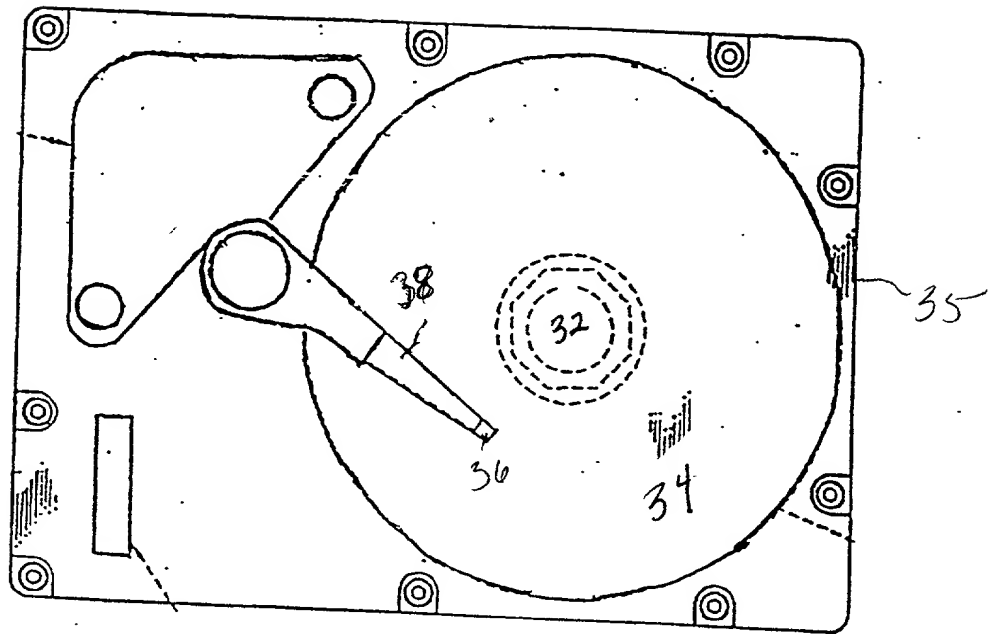


FIG. 4

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DECLARATION FOR PATENT APPLICATION

As a below-named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated below next to my name,

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled **HIGH MODULUS AND HIGH DAMPING PLASTIC COMPOSITE DISC SUBSTRATE FOR IMPROVED SERVO CONTROL BY INJECTION AND CO-INJECTION MOLDING**, the specification of which:

(check one) ☐ is attached hereto.
☒ was filed on May 18, 1999 and having
Attorney Docket No. A-66435/JAS/MSS
appearing on the specification as filed.

I hereby state that I have reviewed and understand the contents of the above-identified specification, including the claims, as amended by any amendment referred to above.

I acknowledge the duty to disclose to the Patent Office all information known to me to be material to patentability as defined in 37 C.F.R. 1.56.

I hereby claim foreign priority benefits under Title 35, United States Code, §119 of any foreign application(s) for patent or inventor's certificate listed below and have also identified below any foreign application for patent or inventor's certificate having a filing date before that of the application on which priority is claimed:

Prior Foreign Application(s)

Priority Claimed

(Number)

(Country)

(Day/Month/Year Filed)

☐

Yes

☐

No

I hereby claim the benefit under Title 35, United States Code, §119(e) of any United States provisional application(s) listed below:

60/086,360
(Application Serial No.)

May 19, 1998
(Filing Date)

Pending
(Status)
(patented, pending, abandoned)

I hereby claim the benefit under Title 35, United States Code, §120 of any United States application(s) listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States application in the manner provided by the first paragraph of Title 35, United States Code, §112, I acknowledge the duty to disclose to the Patent Office all information known to me to be material to patentability as defined in 37 C.F.R. 1.56 which occurred between the filing date of the prior application and the national or PCT international filing date of this application:

(Application Serial No.)

(Filing Date)

(Status)
(patented, pending, abandoned)

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File No. A-66435/JAS/MSS

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Title 18, United States Code, §1001 and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

Full name of first or sole
inventor, if any

Stanley Dale Vierk

Inventor's signature:

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